Name Mr. Shank

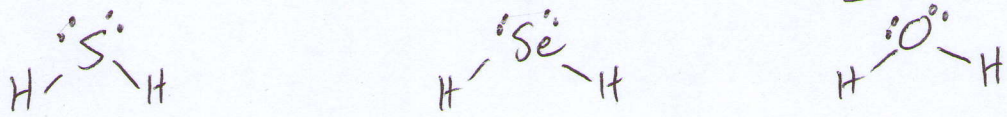
Class AP 1, 2, 3

30

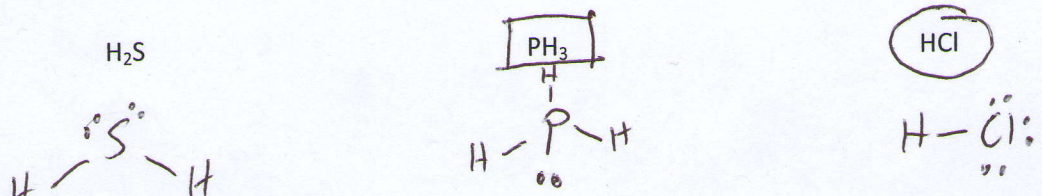
Acids and Bases II

Draw Lewis structures of each of the molecules below. For each group of three molecules, circle the strongest acid and box the weakest acid.

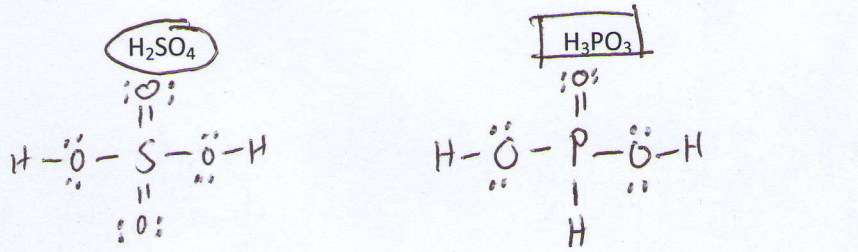
1. H_2S H_2Se H_2O



2. H_2S PH_3 HCl



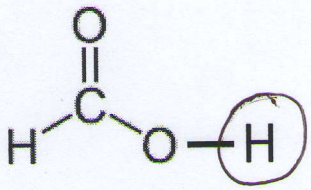
3. H_2SO_4 H_3PO_3 H_3PO_4



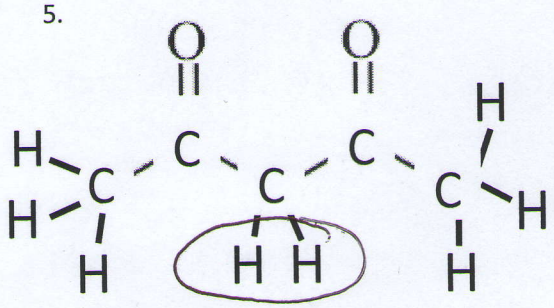
+14

Circle the most acidic hydrogen(s) on the Lewis structures of each the following molecules.

4.



5.



+2

Write a balanced chemical equation for the following reactions.

6. The reaction of Na_2CO_3 with water.

$Na_2CO_3 \xrightarrow{H_2O} 2Na^+ + CO_3^{2-}$

$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$

7. The reaction of $NaHCO_3$ with water (treat water as a base).

$NaHCO_3 \xrightarrow{H_2O} Na^+ + HCO_3^-$

$HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_3O^+$

8. The reaction of $NaHCO_3$ with water (treat water as an acid).

$NaHCO_3 \xrightarrow{H_2O} Na^+ + HCO_3^-$

$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$

+6

+22

Professor Sun studied the reactions of acids and bases by adding specific volumes of 0.2 M NaOH to 30 mL of 0.1 M HCl.

9. The following table lists the volume of NaOH Professor Sun added in each of nine experiments. Complete the table by calculating the indicated quantities in each experiment. All answers should include two numbers after the decimal point. You **must** show your calculations in the space below the table.

Volume NaOH added (mL)	0	5	10	15	20	25	30
Final pH	1	1.24	1.60	7	12.30	12.56	12.70
Final pOH	13	12.76	12.40	7	1.70	1.44	1.30

Must show calculations here:

Initial mol H_3O^+ = Initial mol HCl = $(30\times10^{-3}\,L)(0.1\,mol/L) = 3\times10^{-3}$ mol

0 mL added

$pH = -\log[H_3O^+]$

$[H_3O^+] = [HCl] = 0.1M$

$pH = -\log(0.1) = 1$

10 mL added

mol OH^- added $= 10\times10^{-3}\times0.2 = 2\times10^{-3}$ mol

R	H_3O^+	+ OH^-	⇆	$2H_2O$
I	3×10^{-3}	2×10^{-3}		—
C	-2×10^{-3}	-2×10^{-3}		—
E	1×10^{-3}	0		—

$pH = -\log\left(\frac{1\times10^{-3}}{40\times10^{-3}}\right) = 1.6$

20 mL added

mol OH^- added $= 20\times10^{-3}\times.2 = 4\times10^{-3}$ mol

R	H_3O^+	+ OH^-	⇆	$2H_2O$
I	3×10^{-3}	4×10^{-3}		—
C	-3×10^{-3}	-3×10^{-3}		—
E	0	1×10^{-3}		—

$pOH = -\log[OH^-] = -\log\left(\frac{1\times10^{-3}}{50\times10^{-3}}\right) = 1.70$

5 mL added

R	H_3O^+	+ OH^-	⇆	$2H_2O$
I	3×10^{-3}	1×10^{-3}		—
C	-1×10^{-3}	-1×10^{-3}		—
E	2×10^{-3}	0		—

} mol

mol OH^- added $= 5\times10^{-3}\times0.2 = 1\times10^{-3}$ mol

$pH = -\log\left(\frac{2\times10^{-3}\ mol}{35\times10^{-3}\ L}\right) = 1.24$

15 mL added

mol OH^- added $= 3\times10^{-3}$ mol = initial mol H_3O^+

neutral solution

$pH = 7$ +8

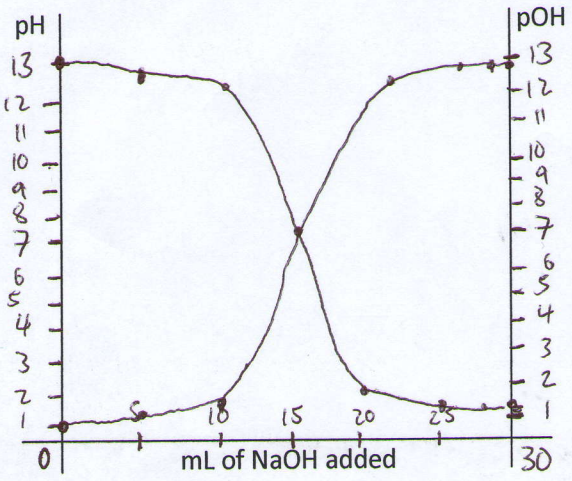
25 mL added

mol OH^- added $= 25\times10^{-3}\times.2 = 5\times10^{-3}$ mol

R	H_3O^+	+ OH^-	⇆	$2H_2O$
I	3×10^{-3}	5×10^{-3}		—
C	-3×10^{-3}	-3×10^{-3}		—
E	0	2×10^{-3}		—

$pOH = -\log\left(\frac{2\times10^{-3}\ mol}{55\times10^{-3}\ L}\right) = 1.44$

10. Using the values you calculated above, complete the following graph.



EC. What volume of 0.2 M $Ba(OH)_2$ must be added to 10 mL of 0.3 M HNO_3 in order produce a solution with pH = 2?

V = volume $Ba(OH)_2$ added in mL

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

$HNO_3 \rightarrow H^+ + NO_3^-$

R	H_3O^+	+ OH^-	⇆	$2H_2O$
I	3×10^{-3}	$4V\times10^{-4}$		—
C	$-4V\times10^{-4}$	$-4V\times10^{-4}$		—
E	$3\times10^{-3} - 4V\times10^{-4}$ mol	0		—

$pH = -\log[H_3O^+]$

$[H_3O^+] = 10^{-pH}$ +1

$[H_3O^+] = 10^{-2}$

$\frac{3\times10^{-3} - 4V\times10^{-4}}{(10+V)\times10^{-3}} = 10^{-2}$

$3\times10^{-3} - 4V\times10^{-4} = 10^{-4} + V\times10^{-5}$

$2.9\times10^{-3} = (4.1\times10^{-4})V$

$V = \frac{2.9\times10^{-3}}{4.1\times10^{-4}}$

V = 7.07 mL of $Ba(OH)_2$ added